

## Magnetism and Electromagnetism

### AP Physics

#### 1. Magnetism:

- a. Only dipoles exist.
- b. Right-hand rule #1:
  - i. Determines the direction of the velocity, magnetic field, and magnetic force.
  - ii. Special cases when angles at maximum or minimum.
- c. Definition of magnetic field:
  - i. Variables (units): Magnetic field (Tesla: T), force (N), charge (C), velocity (m/s), angle (degrees).
  - ii. Equation.
- d. Mass spectrometer.
- e. Force on a current in a magnetic field:
  - i. Variables (units): Force (N), current (A), length (m), magnetic field (T), angle (degrees).
  - ii. Equation.
  - iii. Special cases when angles maximum or minimum.
- f. Magnetic fields produced by currents:
  - i. Right-hand rule #2.
  - ii. Variables (units): Magnetic field (T), current (A), distance (m).
  - iii. Equation.
  - iv. Loop of wire:
    1. Variables (units): Number of turns (unitless), current (A), radius (m).
    2. Equation.
  - v. Solenoid: multiple loops of wire; magnetic field uniform inside loop.

#### 2. Electromagnetic Induction:

- a. Induced emf and induced current.
- b. Motional emf:
  - i. Variables (units): Electromotive force (V), velocity (m/s), magnetic field (T), length (m).
  - ii. Equation: Velocity, magnetic field, and length are all mutually perpendicular.
  - iii. Used to generate electricity.
- c. Magnetic flux:
  - i. Variables (units): Magnetic flux [ $\Phi$ ] (Webers: Wb), magnetic field (T), area ( $m^2$ ), angle (degrees).
  - ii. Equation.
  - iii. Understand the direction of the angle.
- d. Faraday's law and Lenz's law.
  - i. Variables (units): Electromotive force (V), number of turns (unitless), magnetic flux (Wb), time (s).
  - ii. Equation.